5.0 IMPACT OF ALTERNATIVE EXPOSURE ASSUMPTIONS

Based on the equations and assumptions presented in the 1996 Baseline HHRA, the action level for arsenic in soil at the Anaconda Smelter NPL site of 250 ppm equates to a lifetime excess cancer risk estimate of 8.4×10^{-5}. If this soil concentration is used with the equations and assumptions presented in this assessment (Section 3.0), the estimated lifetime excess cancer risk would be 3.6×10^{-4}. The latter risk estimate exceeds 1×10^{-4} and is outside of the range that US EPA, in general, deems appropriate. Further, it exceeds nearly all of risk estimates associated with the arsenic action levels identified in RODs for other sites (Table 10) (the only exceptions are the action levels for the Tacoma Smelter site, which is not applied to residential yards; the Rockwool Industries site, which is zoned for industrial use; and the Rhone-Poulenc Zoecon site, which has institutional controls prohibiting future residential use). The risk assessment I developed herein is based on U.S. EPA guidance, incorporating additional likely-to-be complete exposure pathways and correctly calculated variables were appropriate. In addition, my risk assessment incorporates assumptions based on additional defensible sources of information, including the scientific literature and risk assessment guidance as well as a site visit and a survey of members of the Opportunity community. The result of this risk assessment is that the estimated screening level for arsenic soil decreased from 250 ppm to approximately 8 ppm. Following Agency's policy, then this change would require remediation of contaminated soil in Opportunity to an acceptable level.

I selected many exposure parameters to reflect mean or median values (e.g., meat and produce ingestion rates, soil contact rates), as opposed to upper bound estimates, and to reflect realistic estimates of site-related exposures. However, different values could be used for several key parameters in the risk calculations. To assess the potential impact of alternative values for these parameters, I explored the use of alternative values for several exposure parameters that could significantly impact the total estimated risk, focusing on important parameters in the four most significant exposure pathways identified in Section 3.2. These exposure parameters are as follows:

- Relative oral bioavailability factor for soil
- Relative oral bioavailability factor for dust
- Relative concentration of arsenic in dust compared to soil
- Soil and dust ingestion rates
- Produce ingestion rates
- Meat ingestion rates

The alternatives assumptions and effects on the risk calculations and screening levels are discussed below.

5.1 Relative Oral Bioavailability (RBA) Factors

As shown in Table 4, the RBA values applied in the CDM (1996) Baseline HHRA are at the lower end of RBA estimates for arsenic that have been reported in *in vivo* studies conducted using soil from mining or smelting sites: values for other sites where soil was contaminated by mining or smelting activity range from 5% to 98%, with a mean value for the 24 sites of 34.9%. The mean value for the six sites where studies were conducted in monkeys was 14.2%, whereas the mean value for the remaining 18 sites where studies were conducted in swine or mice was 42.4%. As discussed in Section 2.2.4.2 and 2.2.4.4, a number of methodological concerns with the monkey studies suggest

that use of the monkey model is more likely (than not) to underestimate the oral bioavailability of arsenic in soils.

While U.S. EPA (2012b) recommends using site-specific bioavailability data when available, concerns with the site-specific data suggest reconsideration of the RBA estimates applied in the CDM (1996) Baseline HHRA may be warranted.

If an alternative oral bioavailability factor for soil and dust equal to the mean soil RBA value for all the smelting/ mining sites is used (35%), the resulting lifetime excess cancer risk for the Opportunity Community residential scenario (based on the equations and assumptions described in Section 3.0) increases to 3.0×10^{-4}, and the calculated soil screening level at a target cancer risk of 1×10^{-5} decreases to 6.1 ppm. Note that Freeman et al. (1995) suggests the RBA for arsenic in dust may be greater than that in soil; however, no dust RBA data for any other sites were identified, and so a value based on soil was applied to dust in this recalculation. This may underestimate uptake of arsenic from dust at the site.

5.2 Relative Concentration of Arsenic in Dust

As discussed in Section 2.2.3, data on arsenic concentrations in soil and dust collected in the Community Soils OU in 2006 and 2007 (Pioneer Technical Services, 2009) suggest that concentrations of arsenic in indoor dust were relatively higher than in outdoor soil. In the reassessment of residential risks, a value for the relative concentration of arsenic in dust of 130% is assumed, based on the average relative concentration for the sampled homes in Opportunity, Anaconda West, and Anaconda East. However, in some cases, the relative concentration of arsenic in indoor dust was much higher, and the average relative concentration of arsenic in indoor dust vs outdoor soil is relatively higher in Opportunity (170%) when considered separately from the Anaconda homes (average 110%).

If an alternative value for relative concentration of arsenic in indoor dust of 170% is used, the resulting lifetime excess cancer risk for the Opportunity Community residential scenario (based on the equations and assumptions described in Section 3.0) increases to 2.8×10^{-4}, and the calculated soil screening level at a target cancer risk of 1×10^{-5} decreases to 6.6 ppm.

Available data suggest that the relative concentrations of arsenic in attic dust tend to be much higher than in other areas of the house. However, separate assumptions to estimate exposure to attic dust were not made in this assessment, since it was assumed that contact with attic dust was minimal. However, if a resident regularly spends time in the attic, or if exposures to dust in some other area of the home more closely approximate attic concentrations, this assessment may underestimate total arsenic exposures.

5.3 Soil + Dust Ingestion Rates

In this assessment, we assumed a soil ingestion rate of 100 mg/d for an adult and 200 mg/d for a child; these values were not changed from the CDM (1996) Baseline HHRA as these remain the U.S. EPA recommended default assumptions for this scenario (U.S. EPA, 1996b; U.S. EPA, 2012d). In the 2011 *Exposure Factors Handbook*, U.S. EPA reevaluates soil and dust ingestion rate data for adults and children and suggests average soil + dust ingestion rates of 50 mg/d for adults and 110 mg/d for children (U.S. EPA, 2011).

If these alternative values for soil + dust ingestion are used, the resulting lifetime excess cancer risk for the Opportunity Community residential scenario (based on the equations and assumptions

described in Section 3.0) decreases to 1.9×10^{-4}, and the calculated soil screening level at a target cancer risk of 1×10^{-5} increases to 9.7 ppm.

5.4 Produce Consumption Rates

Separate produce consumption rates were applied for three different categories of produce: above ground exposed, above ground protected, and below ground (root) vegetables or fruit. These categories are used because it is assumed that contaminants are taken up from soil into these groups of produce at different rates. Per Baes et al. (1985),

> Exposed produce (snap beans, tomatoes, apples, etc.) intercept atmospherically depositing material on edible surfaces, but surface areas for exposure are relatively small compared to leafy vegetables. Additionally, edible portions are typically concerned with reproductive functions (fruits and seeds). Protected produce (potatoes, peanuts, citrus fruits, etc.) are not directly exposed to atmospherically depositing material because their growth habit is underground, or if aboveground, the edible portions are protected by pods, shells, or nonedible skins or peels. Typically, edible portions are reproductive or storage organs.

For estimating concentrations of arsenic in produce, uptake from soil only was assumed (i.e., deposition of airborne particulate onto the plant surface was not evaluated). If deposition of airborne arsenic onto edible produce was significant, this assessment may underestimate total arsenic exposures.

As discussed in Section 3.2, the assumed homegrown produce consumption rates applied in this risk assessment were equivalent to the following for adults:

- *Consumption rate of aboveground exposed produce* = 1.36 g/ kg BW-d (fresh weight, converted to 0.171 g /kg BW-d dry weight). Assuming a typical adult body weight of 70 kg, this equates to 95 g/d (or 3.4 ounces/d), which is equivalent to consumption of about 2 cups of lettuce.
- *Consumption rate of aboveground protected produce* = 0.55 g/ kg BW-d (fresh weight, converted to 0.122 g /kg BW-d dry weight). Assuming a typical adult body weight of 70 kg, this equates to 38.5 g/d (or 1.4 ounces/d), which is equivalent to consumption of about 1/4 cup of fresh peas.
- *Consumption rate of belowground produce* = 1.03 g/ kg BW-d (fresh weight, converted to 0.229 g /kg BW-d dry weight). Assuming a typical adult body weight of 70 kg, this equates to 72.1 g/d (or 2.5 ounces/d), which is equivalent to consumption of about one carrot.

On an annual average basis, 25% of all vegetables consumed was assumed to be from home gardens. Alternatively, some residents may eat more homegrown produce, and some may eat less or no homegrown produce. However, it is clear based on surveys of Opportunity Community residents that at least some residents do consume homegrown produce.

The consumption rates of aboveground exposed produce and aboveground protected produce are based on U.S. mean values for consumption of vegetables only. Mean consumption rates of exposed fruits and protected fruits are also available. Some residents of Opportunity report eating home-grown berries (strawberries, raspberries), which could be classified as above ground exposed fruits. U.S. EPA reports the following for this category, for adults:

- *Consumption rate of mixed berries, by consumers* = 0.23 g/ kg BW-d (fresh weight, converted to 0.029 g /kg BW-d dry weight). This represents the mean intake of mixed berries reported for consumers in the U.S. population, ages 20-69 (U.S. EPA, 2011b). Assuming a typical adult body weight of 70 kg, this equates to 16 g/d (or 0.57 ounces/d), which is equivalent to consumption of

about 1/8 cup of raspberries per day. On an annual average basis, 50% of all raspberries consumed was assumed to be from home gardens.

Based on these observations and data, several alternative assumptions for this pathway were made as follows:

- If one-third (33%), rather than 25%, of all consumed produce is assumed to be homegrown, the resulting lifetime excess cancer risk for the Opportunity Community residential scenario increases to 2.8×10^{-4}, and the calculated soil screening level at a target cancer risk of 1×10^{-5} decreases to 6.6 ppm.
- If produce consumption is assumed to include consumption of berries per the above assumptions, the resulting lifetime excess cancer risk for the Opportunity Community residential scenario increases slightly to 2.7×10^{-4}, and the calculated soil screening level at a target cancer risk of 1×10^{-5} decreases to 6.8 ppm.
- If it is assumed that no homegrown produce is consumed, the resulting lifetime excess cancer risk for the Opportunity Community residential scenario decreases to 1.5×10^{-4}, and the calculated soil screening level at a target cancer risk of 1×10^{-5} increases to 12.2 ppm.

5.5 Meat Consumption Rates

The homegrown meat consumption rates applied to estimate the lifetime excess cancer risk for the Opportunity Community residential scenario, discussed in Section 3.2, were as follows for adults:

- *Consumption rate of aboveground exposed meat* = 0.59 g/ kg BW-d (fresh weight). Assuming a typical adult body weight of 70 kg, this equates to 41 g/d (or 1.5 ounces/d), which is equivalent to consumption of about 10 ounces of homegrown meat per week.

Alternatively, some residents may eat more homegrown meat, and some may eat less or no homegrown meat. For this pathway, several alternative assumptions were made as follows:

- If a person is assumed to eat twice as much homegrown meat (about 20 ounces per week for an adult), the resulting lifetime excess cancer risk for the Opportunity Community residential scenario increases to 2.6×10^{-4}, and the calculated soil screening level at a target cancer risk of 1×10^{-5} decreases to 7.1 ppm.
- If a person is assumed to eat no homegrown meat, the resulting lifetime excess cancer risk for the Opportunity Community residential scenario decreases slightly to 2.3×10^{-4} and the calculated soil screening level increases slightly to 8.0 ppm.

If a person is assumed to eat no homegrown produce or homegrown meat, the resulting lifetime excess cancer risk for the Opportunity Community residential scenario decreases to 1.4×10^{-4} and the calculated soil screening level increases to 13.1 ppm.

6.0 Summary and Conclusions

The risk assessment conducted herein was performed in a manner consistent with standard U.S. EPA risk assessment guidance. It incorporates numerous updated assumptions including site-specific information about the relative concentration of arsenic in soil and dust and information from community residents that indicates they consume, or have consumed, homegrown produce and in some cases raised livestock for consumption.

The result of this assessment is an estimated lifetime excess cancer risk associated with exposure to arsenic in soil and dust of 2.5×10^{-4}. By comparison, the estimated cancer risks for arsenic exposure presented in the Baseline HHRA for the Opportunity resident scenario were 5.51×10^{-5} for the RME scenario and 7.01×10^{-6} for the CTE scenario—the risks presented in this assessment are 4.5 to 36-fold higher than those presented in the Baseline HHRA. Further, based on the equations and assumptions presented in the 1996 Baseline HHRA, an action level for arsenic in soil at the Anaconda Smelter NPL site of 250 ppm was established. If this soil concentration is used with the equations and assumptions applied in the assessment presented in this report, the estimated lifetime excess cancer risk for an Opportunity resident would be 3.6×10^{-4}, a 4.3-fold increase over the lifetime excess cancer risk of 8.4×10^{-5} assumed to be associated with the 250 ppm action level in the Baseline HHRA and the ROD. These risks are greater than the Agency's general acceptable risk threshold of 1×10^{-4}. Note this risk estimate is solely arsenic-based. Other chemical exposures, not included here, would increase the risk estimate.

The soil screening level calculated in the current report, based on an acceptable lifetime excess cancer risk level of 1×10^{-5} and the assumptions described herein, is approximately 8 ppm. This recalculated screening level is appropriate and consistent with other arsenic soil action levels established nationwide. The original U.S. EPA ROD action level of 250 ppm is one of the highest action levels for arsenic in the U.S. EPA RODs nationwide.

Where we could not obtain better scientific data, we used the same parameters as the Baseline HHRA conducted in 1996. For example, while I believe for several reasons that the site-specific monkey study underestimates bioavailability, we used values from that study in this assessment. If the bioavailability was in fact higher than indicated by the monkey study, the risk estimated here would be greater than 2.5×10^{-4}; as such, my assessment is conservative and if an alternative estimate of relative bioavailability were used, the estimated risks would be calculated to be higher.

My review of the U.S. EPA Superfund ROD for the Anaconda Company Smelter in Anaconda, MT (U.S. EPA, 1998a), the *Final Baseline Human Health Risk Assessment, Anaconda Smelter NPL Site, Anaconda, MT* (CDM, 1996) has found that their arsenic risk estimate and residential action level of 250 ppm is not appropriate. According to the standard practice of toxicological risk assessment, the documents' calculations contain a number of errors and omissions. I further note that, when using a standard risk assessment approach, the 250 ppm figure presents a greater estimate of cancer risk than the documents indicate. Using current data and practices, I have found a scientifically reliable soil screening level to be approximately 8 ppm. This is assessed on a more probable than not basis.

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EXHIBIT D

Expert Report
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Gregory A. Christian, et al., v. BP Amoco Corporation, et al., Atlantic Richfield Company, et al., Cause No. DV-08-173

Qualifications

I, John R. Kane, have worked in the Environmental Consulting field for 26 years. I am currently the CEO/President of Kane Environmental, Inc. based in Seattle, Washington. I have been working in this position for 13 years. My CV is attached.

During my 26 years of professional experience my main focus has been on contaminant investigation and remediation of soil and groundwater. My experience includes a wide variety of contaminants including metals, solvents, pesticides, PCBs, wood treating chemicals and petroleum.

I have supervised, designed, installed, and monitored various types of remedial technologies including soil vapor extraction, groundwater sparging, bioremediation, bioventing, monitored natural attenuation, passive barrier wall treatment, and excavation and off-site disposal.

Scope of Inquiry

On behalf of the plaintiffs, the owner's of private property located in Opportunity and Crackerville, Montana, I have been asked to investigate metals contamination in soil and groundwater on their property to determine whether restoration for their property is technologically and economically feasible and if so, to determine the cost and scope of work for restoration. I have completed similar work for private property locations

associated with the former smelter located in North Everett, Washington, and residential properties in the vicinity of the former Asarco smelter in Tacoma, Washington. I worked as a field geologist on the Old Works and Smelter Hill sites from approximately 1987 to 1989 timeframe for a previous employer.

Opinions and information contained in this disclosure are based on review of available site information provided in ARCO and governmental documents, site investigation data results, and sampling data from Kane Environmental's soil, indoor dust, and groundwater sampling/testing work. ARCO's reports contain data collected by other consultants and contractors and the data were reviewed and compared with data collected by Kane Environmental and used for the basis of the opinions expressed in this disclosure. The attachments to this report may be used as exhibits at trial. Due to the volume of reference documents and data, and on-going investigations by ARCO's consultant and Kane Environmental, it is my intention to review and collect additional data before trial. I reserve the right to modify and/or supplement my opinions and attachments based on the review or collection of additional data and/or reports.

Facts and Opinions

Based on my review of existing data, I expect to testify to the following opinions:

1) Operations at the former Anaconda Smelter (Smelter Hill) resulted in significant and substantial contamination of arsenic and heavy metals detected above background concentrations from smelter emissions in soil and groundwater on private property in Opportunity and Crackerville.

2) Metals in soil and groundwater have known health effects and some are known carcinogens.

3) ARCO's testing and analysis provided inadequate characterization of the extent of metals soil and groundwater contamination above background in the residential areas in Opportunity and Crackerville.

4) Contrary to ARCO's representations, restoration of contaminated private property residential soils and shallow groundwater is feasible using accepted methods of cleanup.

5) The estimated cost to restore soil and groundwater on the plaintiffs private property is attached in Table 1.

6) Concentrations of arsenic and heavy metals were found in dust sampling conducted inside plaintiff's residences.

SUMMARY OF GROUNDS FOR OPINIONS

1) Operations at the former Anaconda Smelter (Smelter Hill) resulted in significant and substantial contamination of arsenic and heavy metals detected above background concentrations from smelter emissions in soil and groundwater on private property in Opportunity and Crackerville.

I have been asked to determine whether historical smelting operations at Smelter Hill resulted in concentrations of metals in soil and groundwater above background on private property owned by citizens of Opportunity and Crackerville that have brought this lawsuit. I determined the concentrations of arsenic and cadmium, copper, lead, and zinc in the soil and groundwater on the private properties. To determine whether the properties are contaminated, background concentrations of arsenic, cadmium, copper, lead and zinc were calculated from soil collected at the private properties, and from drinking water well data from the Opportunity and Crackerville areas obtained from the Montana Bureau of Mines and Geology. Based on my education, experience and review of historical data related to operations at Smelter Hill, I concluded that the most likely cause of the elevated arsenic and heavy metals in the soil and groundwater in Opportunity and Crackerville is from the operations at Smelter Hill.

1a. Background Concentrations of Arsenic and Other Heavy Metals

Background soil and groundwater concentrations were calculated for Opportunity and Crackerville based on soil samples collected during Kane Environmental's investigation

and using drinking water well data collected from drinking water wells in Opportunity and Crackerville areas from the Montana Bureau of Mines and Geology database.

Soil samples collected with a starting depth of 2 feet or more and beneath the surface from each sampling location in the unsaturated zone, was used to calculate background concentrations of arsenic, cadmium, copper, lead and zinc. Soil analytical data from the June and October 2012 soil sampling investigations were used. Laboratory duplicate analyses were used in the calculations. One-half the laboratory test detection limit was considered non-detectable concentrations of metals. A total of 168 samples were used to calculate background concentrations. The following mean (average) for each metal in parts per million (ppm) is:

Arsenic	12.98
Cadmium	0.232
Copper	17.94
Lead	9.577
Zinc	38.76

The median concentrations in ppm of the five metals is:

Arsenic	6.445
Cadmium	0.111
Copper	11.75
Lead	7.315
Zinc	32.70

Groundwater background concentrations were calculated using total metals from the Montana Bureau of Mines and Geology, using wells greater than or equal to 20 feet below ground surface. Only one duplicate laboratory result was reported in the database and it was not used in the background calculations. Test method detection limits were used because method detection limits were not provided in the Montana Bureau of Mines and Geology drinking water database. A total of 107 samples were used from a depth greater than or equal to 20 feet.

The following mean (average) for each metal in parts per billion (ppb) is:

Arsenic	1.134
Cadmium	0.432
Copper	6.856
Lead	1.106
Zinc	37.67

The median concentrations of the five metals is:

Arsenic	0.515
Cadmium	0.50
Copper	4.64
Lead	0.50
Zinc	5.34

Based on these sampling results, a reasonable range of background levels of arsenic and other heavy metals in soil and shallow groundwater is between the median and mean background concentrations.

1b. Levels of Arsenic and Other Heavy Metals Present in Soil and Groundwater.

ARCO's consultant collected groundwater samples from wells in the Crackerville area and south of Opportunity in 2003. Figure 1 (South Opportunity Area of Concern Investigation Sample Locations) and Figure 2 (Dutchman Creek Area of Concern Investigation Sample Locations) are provided in the appendices for reference. Concentrations of arsenic, cadmium, copper, lead, and zinc were found above background in some of the groundwater samples collected by ARCO's consultant.

On the plaintiffs properties, Kane Environmental conducted soil sampling and groundwater investigation in June and October 2012, and indoor dust sampling and additional soil and groundwater sampling in March 2013. Soil sampling conducted by Kane Environmental is consistent with and similar to the sampling conducted by ARCO's consultant during the summer of 2012.

Our findings reveal concentrations above the calculated background concentrations of arsenic, cadmium, copper, lead and zinc in soil and groundwater in Opportunity and Crackerville. Concentration contour maps showing distribution of contamination are provided in the attachments of this report. Figure 4-16 (Extent of Arsenic Contamination in Groundwater in the ARWW&S OU Final Site Characterization Report) prepared on behalf of ARCO shows an approximate north to northeastern extent of arsenic contaminated groundwater at or near Highway 1. Our findings are contrary to the findings shown in Figure 4-16 and discussed in Section 7.4 of the ARWW&S OU Final Site Characterization Report prepared on behalf of ARCO.

Sampling data has been reviewed, evaluated, and validated using guidance and quality control criteria documented by recognized analytical methods. See attached EcoChem, Inc. reports October 12, 2012 and April 1, 5, 8, and 10, 2013, incorporated herein.

1c. The Cause of the Contamination of Soil and Groundwater in Opportunity and Crackerville, MT.

The most likely reason for the elevated levels of arsenic and heavy metals in the soil and groundwater on the private property of the citizens of Opportunity and Crackerville is the operation of the smelter in Anaconda, MT by the Defendants or their predecessor corporations. Opportunity, Montana, is located at the south end of the Deer Lodge Valley, east of Anaconda, and Crackerville is also located east of Anaconda and south of Opportunity. Both communities are downwind of the giant Washoe smelter that operated near Anaconda from 1902 to 1980. The Anaconda Company and its predecessors operated the smelter. The Anaconda Company (known over time as the Anaconda Gold and Silver Company, the Anaconda Mining Company, the Anaconda Copper Mining Company, and The Anaconda Company) operated metallurgical reduction works (called smelters) at Anaconda from 1884 until 1980. Throughout that period, the smelters discharged smoke containing hazardous materials, including sulfur dioxide, arsenic, copper, and other heavy metals.

I have reviewed the expert report of Dr. Quivik. According to Dr. Quivik:

> *When the smelter opened in 1902, it was discharging an estimated 25 tons of arsenic trioxide per day, and in 1903 that figure rose to about 39 tons per day, before the ACM closed the smelter and installed the flue system and the 300-foot stack. After the smelter re-opened, it was discharging about 23-30 tons of arsenic trioxide per day, until copper production began to increase in the 1910s. The stack discharged about 40 tons of arsenic trioxide per day in 1911 and peaked at about 62 tons per day in both 1916 and 1918. After the construction of the Cottrell electrostatic treaters and the 585-foot stack, discharges of arsenic trioxide dropped to about six tons per day throughout the 1920s.*
>
> *****
>
> *Copper discharges peaked in 1916 and 1918 at about eight tons per day. With the Cottrell treaters, copper discharges dropped to below 0.2 tons per day. Lead discharges peaked at more than ten tons per day in 1916 and 1918, and then dropped to about 1.5 tons per day in the 1920s with the use of the Cottrell treaters.*

The smelter operated until 1980, and continued to deposit arsenic and other heavy metals onto the soil in Opportunity and Crackerville.

The Final Remedial Investigation Report for the Anaconda Regional Water, Waste & Soils Operable Unit (ARWW&S OU) prepared for ARCO and dated February1996 states in the conclusions section that:

> *Based on all available data, two potential sources responsible for low-level contamination of dissolved arsenic in groundwater of the alluvial aquifer have been identified in the vicinity of Willow Creek near MW225. The first source is an area of tailings located in the floodplain between Willow Creek and Silver Bow Creek. The second source is contaminated soil due to widespread deposition of smelter emissions.*

Both the United States Environmental Protection Agency (U.S. EPA) and Montana Department of Environmental Quality (DEQ) likewise concluded that the contamination

in Opportunity and Crackerville was due to the smelter operation. U.S. EPA and DEQ issued the ARWW&S OU Record of Decision (ROD R08-98/096 1998) including the rural communities of Opportunity and Crackerville in the South Opportunity Subarea. A ROD Amendment for the ARWW&S OU was issued by both agencies in September 2011.

The ROD and ROD Amendment state that "*widespread areas of contaminated soil are characterized in the South Opportunity Subarea as a result of deposition of smelter stack emissions*". These documents further report that groundwater contamination in the South Opportunity Subarea is characterized in portions of the alluvial aquifer underlying areas of contaminated soils which are flood irrigated on a year round basis in the vicinity of the Yellow Ditch, and in portions of the aquifer underlying wastes and contaminated soils at the Blue Lagoon. The depth of ground water contamination in this portion of the aquifer is reportedly estimated to range from less than 10 feet to approximately 30 feet. Potential loading sources for metals to the aquifer in this area include leaching of metals from wastes in railroad grade material, from contaminated soils, and from contaminated sediment of the Blue Lagoon. The depth of ground water contamination at the Blue Lagoon is thought to be limited to the upper 10 feet of the aquifer.

The ROD documents both report that the results of these studies indicate that arsenic is present in the ground water at the top of the aquifer over a large area of South Opportunity at concentrations up to 150 ppb. This plume is limited to the upper few feet of the aquifer and has not been detected in any domestic wells, which tend to penetrate past the top of the aquifer. This plume occupies two general areas: along Willow Creek and between Willow Glen Ranch and the Town of Opportunity. Based on historic mapping, this widespread plume coincides with areas that have been flood irrigated. One monitoring well, MW-232, has contained significantly higher arsenic than the ground water elsewhere in South Opportunity. This monitoring well is downgradient of Yellow Ditch and in an area that was irrigated before 1996. Possible sources of elevated arsenic in the MW-232 area include contaminated sediments in Yellow Ditch, contaminated water flowing into Yellow Ditch, or a combination of the two. A ground water investigation conducted in 2002 identified elevated arsenic in shallow ground water in one monitoring well in the Crackerville area. (Well SOSPZ26 contained 46 to 79 ppb arsenic in the area between Yellow Ditch and Silver Bow Creek just south of

Crackerville).

The ARWW&S OU Final Site Characterization Report South Opportunity Area of Concern dated September 2011 provides soil, surface water and groundwater data analysis, and conclusions. Section 7.1 Widespread Arsenic Plume states *"Arsenic is present in ground water over a large area of South Opportunity at concentrations up to 150 ug/L (micrograms per liter or ppb). This plume is limited to the upper few feet of the aquifer and has not been detected in any domestic wells which tend to penetrate past the top of the aquifer".*

2) Metals in soil and groundwater have known health effects and some are known carcinogens.

Ingestion of inorganic arsenic increases the risk of skin cancer and cancer in the liver, bladder, and lungs. Inhalation of inorganic arsenic increases the risk of lung cancer. The Department of Health and Human Services (DHHS) and the U.S. EPA have determined that inorganic arsenic is a known human carcinogen. The International Agency for Research on Cancer (IARC) has determined that inorganic arsenic is carcinogenic to humans.

Most cadmium used in the United States is extracted during the production of other metals such as copper, lead, and zinc. Long-term exposure to cadmium in air or water leads to a buildup of cadmium in the kidneys, and other long-term effects are lung damage and fragile bones. DHHS and IARC have determined that cadmium is a human carcinogen.

Copper is released to the environmental by mining and waste water releases into creeks and rivers. Breathing high levels of copper can cause irritation of the nose and throat, and ingestion of high levels of copper can cause damage to the liver and kidneys.

Lead is found in the environment from mining operations and other sources. Lead can affect almost every organ and system in the body, and the main target is the nervous system in adults and children. Exposure to lead can damage the brain and kidneys. DHHS has determined that lead may be a human carcinogen.

3) ARCO's testing and analysis provided inadequate characterization of the extent of metals soil and groundwater contamination above background in the residential areas in Opportunity and Crackerville.

My review of ARCO sampling in Opportunity and Crackerville found limited sampling of soil and groundwater in both communities. For example, a shallow groundwater investigation reported in the Final South Opportunity Ground Water Area of Concern Investigation and Dutchman Creek Ground Water Area of Concern Investigation Data Summary Report (DSR) did not include groundwater sampling north of Highway 1. Figure 1 showing sampling locations in this report is provided in the appendices. There has been insufficient characterization of soil and groundwater contamination compared to my analysis summarized in Opinion 1.

Background soil and groundwater concentrations were calculated for Opportunity and Crackerville based on soil samples collected during Kane Environmental's investigation and using drinking water well data results collected by the Montana Bureau of Mines and Geology from drinking water wells in Opportunity and Crackerville.

4) Contrary to ARCO's representations, restoration of contaminated private property residential soils and shallow groundwater is feasible using accepted methods of cleanup.

4a. Restoring Surface Soil to Background Levels of Arsenic and Other Heavy Metals is Feasible and Practicable. Removal of near-surface residential soils has occurred in some Opportunity and Crackerville private properties. Clean import fill material will be immediately placed in the excavated areas up to 22-inches in depth with a 2-inch thick layer of topsoil and leveled for sod placement for the final cover. The estimated amount of soil to be removed is approximately 430,000 cubic yards (approximately 650,000 tons). Clean import fill can be provided by local sources, used to provide clean fill for the Silver Bow Creek restoration. Removal of the upper 2-feet on private property is appropriate based on calculated site-specific background concentrations for Opportunity and Crackerville.

4b. Restoring Shallow Groundwater to Background Levels of Arsenic and Other Heavy Metals is Feasible and Practicable.

The restoration of groundwater to background levels of arsenic and other heavy metals can be accomplished by installing an underground Passive Reactive Barrier (PRB) wall which contains zero valent iron (ZVI) mixed with clean imported sand. The trench is estimated to be 8,000-foot long, 15-foot deep and 3-foot wide up-gradient of Opportunity. Shorter PRB walls would be placed up-gradient of Crackerville properties. The trenching can be completed either by biopolymer trenching or continuous trenching techniques. For the biopolymer approach, as the trench is excavated, biopolymer slurry is added to the trench to provide stability to the excavated trench walls. Recirculation wells are spaced along the length of the trench. After placement of the ZVI and sand, an enzyme is circulated through the wells to start the biopolymer breakdown process and allow the groundwater to flow through the ZVI PRB. The continuous trenching machines allow simultaneous excavation and backfilling with an open trench. Excavation is performed by a cutting chain immediately in front of a trench box that extends the width and depth of the finished trench. As the trencher moves forward, the ZVI/sand mixture is added to the trench. A PRB pilot test would be required to determine the best installation approach and to determine the amount of ZVI for the PRB walls. These underground PRB walls will be designed to remediate shallow groundwater in Opportunity and Crackerville.

5) The estimated cost to restore soil and groundwater on the plaintiffs private property is attached in Table 1.

Reasonable and necessary costs associated with remediation of plaintiffs' private property are summarized in Table 1, attached. Costs include the removal and restoration of the private properties and transport of the soil to a licensed landfill in Spokane, Washington. An estimated 8,000-foot long, 15-foot deep and 3-foot wide PRB wall would be constructed upgradient of Opportunity, and shorter PRB walls would be placed upgradient of individual Crackerville properties. Soil removal is estimated to take 20 months and installation of the PRB walls 4 to 6 months.

6) Concentrations of arsenic and heavy metals was found in dust sampling conducted in plaintiff's residences.

Kane Environmental conducted an indoor dust survey in 51 residences owned by the private property owners. A portion of the dust analytical results have been data validated, and remaining samples are currently under data validation. Concentrations of arsenic and heavy metals can be removed by HEPA vacuum and monitored with periodic sampling.

John R. Kane

4-15-13

Date

COSTS

TABLE 1

IRON FILINGS WALL GROUNDWATER RESTORATION
SURFACE SOIL EXCAVATION AND RESTORATION

Task 1 - Soil Excavation and Restoration					
Excavator/Operator	400	days	$4,000	$1,600,000	2 excavators 812.5 tons per day; 5 days/ week; 20 months
Soil Disposal Cost	650000	tons	$26	$16,965,000	Disposal at Spokane WA Waste Management Landfill
Soil Disposal Cost - Transportation	650000	tons	$48	$31,200,000	Disposal at Spokane WA Waste Management Landfill
Clean Fill Import	650000	tons	$1	$650,000	
Topsoil	37,000	yards	$1	$37,000	
Sod	6,022,000	sq ft	$0.20	$1,204,400	
SubTotal				**$51,656,400**	
Task 2 - Iron Filings Wall Installation					
Excavator/Operator - Opportunity	80	days	$4,000	$320,000	2 excavators; 5 days/ week; 4 months
Excavator/Operator - Crackerville	40	days	$4,000	$160,000	2 excavators; 5 days/ week; 2 months
Soil Removal for Opportunity Wall	20000	tons	$26	$261,000	Disposal at Spokane WA Waste Management Landfill
Soil Removal for Crackerville Wall	10000	tons	$26	$783,000	Disposal at Spokane WA Waste Management Landfill
Soil Disposal Cost - Transportation	30000	tons	$48	$1,440,000	Disposal at Spokane WA Waste Management Landfill
Iron Filing Wall Installation - Opportunity	120000	vsf	$50	$6,000,000	vertical square feet (vsf) = 15 ft depth x 8000 ft length
Iron Filing Wall Installation - Crackerville	60000	vsf	$50	$3,000,000	vertical square feet (vsf) = 15 ft depth x 4000 ft length
Iron Filing Cost	180,000	vsf	$20	$3,600,000	
Subtotal				**$15,564,000**	
Pilot Test		lump sum	$500,000	$500,000	
Contingency			20%	**$13,444,080**	
Legal Council Cost				$334,000	
SubTotal Task 1, Task 2 and Contingency				**$81,498,480**	
Engineering/Design/Management					
Project Management			5%	$4,074,924	
Remedial Design			5%	$4,074,924	
Construction Management			6%	$4,889,909	
O&M Technical Support			8%	$6,519,878	
SubTotal				**$19,559,635**	
			Estimated Total Project Cost =	**$101,058,115**	